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ABSTRACT

A study investigated how the introduction of a computer writing tool that provides metacognitive guidance to students interacting with it--the Writing Partner2 (WP2)--influenced the classroom environment, and explored both effects "with" and effects "of" working with such a computer tool. Data was gathered from an eighth-grade English classroom that was already using computers in the regular curriculum. Classroom observations, student interviews, and pre- and post-narratives written by the students without the computer were gathered. Results indicated that: (1) traditional gender differences can be decreased by facilitating cross-gender interaction through an integrated seated arrangement; (2) students believed that working with the WP2 had improved their writing; (3) while student interview responses clearly indicated that both effects "with" and effects "of" working with an intelligent computer tool occurred, writing samples revealed no significant improvement, supporting the notion that self-efficacy beliefs are independent from writing performance; and (4) working with the WP2 appeared to create a zone of proximal development for students in a relatively short time (effects with), but for students to be able to internalize the type of support provided by the computer (effects of), it is likely that more time is needed. (Four tables are included; 28 references and 2 appendixes--a scoring rubric and examples of examples of metacognitive questions asked by the WP2--are attached.) (SR)

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The Effects of a Metacognitive Computer Writing Tool on Classroom Learning Environment, Student Perceptions and Writing Ability

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The introduction of computers to today's classrooms has launched a new realm of educational research. The effectiveness of computers as instruction tools has been investigated in numerous content areas such as science (Franz & Papert, 1988; Baird, 1989), reading (Golden, Gersten & Woodward, 1990; Salomon, Globerson, & Guterman, 1990), and writing (Dunn & Reay, 1989; Zellermayer, Salomon, Globerson & Givon, 1989). Unfortunately, the results of such studies have been mixed and often show no differences in intellectual gains between students who use computer tools and those who do not (Dalton & Hannafin, 1988). Furthermore, when looking for transfer, or more long-term effects of using computer tools, the picture is even gloomier (for a review see Salomon & Perkins, 1987). Consequently, when addressing the role of computers in the instructional process the question of whether computer tools can be designed to deliberately enhance performance and learning as well as leave any long-lasting cognitive residue in the form of transferable metacognitive abilities still remains.

The present research sought to investigate possible answers to the above question through the use of a writing computer tool, the Writing Partner2 (WP2), that provides metacognitive guidance to students who interact with the tool. Such interaction can be viewed as an intellectual partnership between the computer and the student. This type of partnership with computer tools can be conceived of as an interaction with "more capable peers" (Vygotsky, 1978) where the computer tool helps students utilize capabilities that are not yet fully developed. If this is the case, such interactions qualify as constituting a Zone of Proximal Development (Vygotsky, 1978) which

is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving in collaboration with more capable peers (p. 86).

It is not sufficient, however, for computer tools to merely provide the support necessary to create a Zone of Proximal Development. Although an intellectual partnership with a computer tool may enhance performance and learning the question still exists of what will happen when the tool is taken away, and the partnership dissolved along with the Zone of Proximal Development. This question deals with what Salomon, Perkins and Globerson (1990) refer to as the effects "*with*" versus the effects "*of*" working with intelligent technology. Effects "with" are concerned with the changes in performance that students display while they are working with an intelligent tool such as a computer program. Effects "of" refer to the relatively lasting changes in students' general cognitive capacities as a result of interaction with an intelligent tool.

The second part of this issue, does such partnership result in cognitive residue or transfer effects (effects of), can be addressed through Vygotsky's (1978) concept of "internalization" where what is developed or learned through the aid of social support is internalized and becomes a part of a person's solo capabilities. In other words, will students who interact with the WP2 be able to internalize the type of metacognitive guidance provided by the computer tool in order to utilize such metacognitive self-guidance on other tasks in the absence of the computer tool?

Another aspect of using computer tools in the classroom is the type of learning environment such tools create. An important part of the learning environment is how students perceive such computer tools and their motivation to interact with computers as an instructional activity. Computer proponents often claim that computers will make learning more intrinsically motivating (Brown, 1985; Lepper, 1985) and researchers who have investigated differences in students' perceptions of learning have found improvements in students' self-reports of their motivation as well as their learning in response to using computers for instructional purposes (Henderson, Landesman, & Kachuck, 1985; Perez & White, 1985). In considering these positive effects of computers in classrooms, however, a caution must be mentioned. Student motivation, perceived self-efficacy and perceptions as learners may be positively affected through interacting with computers but whether these effects endure after the novelty of computer use wears off has yet to be determined (Krendl & Lieberman, 1988). Furthermore, when looking at gender and the use of computers in learning environments significant differences have been found (Becker & Sterling, 1987; Lepper & Chabay, 1985; Siann & Macleod, 1986) which indicates that gender may be an important factor to consider when addressing how computers affect classroom environments.

The present research sought to investigate the following questions: 1) What type of learning environment is created by the introduction of the computer tool?, 2) How do students perceive the computer tool and their partnership with it, and do students believe

their writing ability will improve as a result of working with the computer tool?, and 3) Does interaction with a computer tool that provides continuous metacognitive-like guidance during the writing process, thus creating a Zone of Proximal Development, enhance students' writing ability and leave a cognitive residue in the form of a generalized tendency to be metacognitive when writing without the aid of the computer tool?

Methodology

Data for this project was collected from an eighth grade English classroom that was already using computers as part of their regular curriculum. The class was divided in half for four days a week when half of the class participated in normal classroom instruction led by the teacher. The other half of the class working independently on writing assignments with word processors that were in the classroom. Students began the project using a basic word processing program and were subsequently introduced to the WP2 program. One half of the class worked on the computers Monday and Tuesday (Group A) and the second half worked on the computers Wednesday and Thursday (Group B). Students worked with the WP2 program for six weeks.

The methods used to gather data were classroom observations, student interviews, and pre- and post narratives written by the students without the aid of the computer. Each group was observed for three 50-minute class periods. The first observation was done while students worked with the word processor, the second observation was conducted during each group's first exposure to the WP2, and the third observation was conducted after the students had

worked with the WP2 for four weeks. Structured interviews were carried out the day following the first WP2 observations and again after students were finished working with the WP2. Students were randomly selected for the interviews and the same students were interviewed both times. Two students (one boy and one girl) were interviewed from Group A and three students (one boy and two girls) were interviewed from Group B.

A third set of interviews with five different students (3 girls and 2 boys) was conducted three months after the students had finished working with WP2 in order to obtain students' perceptions of the long-term effects of working with the WP2 and also to support the reliability of the previous interviews. Students were randomly selected for the third interview.

To determine effects of working with WP2 on students' writing, narrative writing samples were collected from each student before and after the project. Students were given a prompt to write from in both writing tasks and had a time limit of one class period (approximately 40 minutes).

Analysis

Domain and taxonomic analyses (Spradley, 1980) were conducted on the classroom observation notes. A third analysis was done with the observation notes to identify possible gender differences in the student-to-student interactions. A domain analysis also was conducted on the transcribed interviews to identify differences in how students perceived working with the word processor versus the WP2, and also to examine whether students thought writing with the word processor or the WP2 improved their writing.

Students' writing samples were scored using holistic rating methods (Freedman & Calfee, 1983). The scoring system was a modification of the system developed by Davis and Monsman (1989). A six point scale (see Appendix A) was used to rate the stories. Each story was scored by three raters. Interrater reliability was .93

Results

Observations. Domain and taxonomic analyses (Spradley, 1980) of the observation field notes revealed changes in the amount and type of student-to-student interactions.

Student-to-Student Interactions. Overall, nonproductive behavior was much more common in the word processing observations than when students were using the WP2. Whereas students were likely to visit, stretch, squirm, and play around with the editing features of the program when writing with the word processor, they were almost continually on task when working with the WP2. This could be due to the fact that students were too busy trying to decipher the new program to have time to engage in nonproductive behaviors such as visiting.

The types of productive interactions also varied as a result of the program being used. Whereas most of the student interaction in the word processing sessions centered around collaboration regarding the process of writing (i.e., sharing stories, giving feedback, offering ideas), the interactions in the WP2 sessions were almost exclusively questions regarding the program (e.g, how to get into program, how to do the highlights and key words in the program). It was expected that this pattern wound change to more closely resemble the collaborative interaction observed in the word

processor sessions as students became more familiar with the WP2 program. The pattern did change but not in the expected direction. In later observations student collaboration of either type (writing or program-help) decreased. This could possibly be due to the fact that the WP2 program was assuming the role of a collaborative partner and therefore, students did not need to rely as heavily on other students for help.

Gender. When addressing the issue of gender in the types and amount of student-to-student interaction it became apparent that if cross-gender interaction is desired, an integrated seating arrangement is necessary. Group A's seating arrangement was almost 100% segregated and as a result, cross-gender interaction was virtually nonexistent. In contrast, Group B's seating arrangement was more integrated and cross-gender interaction was quite common.

There was no evidence in this classroom of several traditional gender differences found in previous research (Becker & Sterling, 1987; Zvacek, 1988). Girls appeared just as motivated as boys to work with the computers and spent as much time as boys working with the computers. Furthermore, there was no evidence of resentment on the boys' part when needing help from a girl as well as no evidence of boys having a superior attitude in their ability to work with computers which has been previously documented (Zvacek, 1988). A possible reason for the lack of gender differences found in this classroom could be the structure of the classroom itself and the environment that has been created by the classroom teacher. The classroom provides a very equitable situation for boys and girls

(e.g., both sexes are required to work with the computer for the same amount of time, are required to do the same assignments). Furthermore, computers are incorporated as a regular part of the curriculum and the teacher's expectations are the same for both boys and girls.

Interviews. Domain analyses on the transcribed interviews focused on students' perceptions regarding the effects on their writing when using the word processor, the effects on their writing when using the WP2 (effects "with"), the long-term effects of working with the WP2 (effects "of"), and the purpose of the metacognitive questions in the WP2 program.

Effects on Writing When Using the Word Processor and Writing Partner2.

In looking at how students thought working with the word processor and WP2 would affect their writing (effects "with"), a definite distinction was found that reflected an "edit/physical-type help versus writing help". The responses students gave for reasons to use the word processor were all concerned with editing, time, physical or practical issues (See Table 1). Moreover, this view was consistent across time. By the third interview, all five students responded that the only reason to use the word processor was that it made writing faster. In comparison, the responses students gave regarding the effects on writing when using WP2 focused much more on the process of writing and the improvement of actual writing skills (See Table 2). As can be seen in Table 2, the factors of elaboration, organization, planning and monitoring appear to be the most salient to students as they were consistently mentioned in all

three interviews. These results seem to indicate that whereas students perceived the word processor as merely a tool to make editing and the physical act of writing easier, they saw the WP2 as more of a partner who was helping them become better writers.

Effects of WP2 on Students' Future or Current Writing. Domain analyses investigating students' perceptions regarding the effects "of" working with the WP2 revealed that students thought working with WP2 would help their future writing (second interview, students still using the WP2) in the areas of elaboration, monitoring, and audience (see Table 3). One student felt it would have minimal effect on future writing because the questions would no longer be provided and more time was needed working with the program. Results from the third interview (when students were no longer working with WP2) revealed that students believed working with WP2 had affected their current writing in areas of elaboration, organization, planning and clarity (See Table 3). Elaboration was the only factor mentioned in both interviews. Results from the second interview indicate that students believed working with WP2 would influence their writing even when they were no longer using the program. Responses in the third interview support this belief as students gave examples of how they thought their writing had changed as a result of working with WP2.

Purpose of Questions. The domain analysis regarding how students perceived the metacognitive questions provided by the program revealed the following categories: elaboration, monitoring, promote thinking, clarity, audience and general (See Table 4). Once again, the factors of elaboration and monitoring were consistently mentioned

during all three interviews, with clarity being mentioned during the second and third interviews. These responses reveal that students perceived the questions as metacognitive guides that enhanced their writing ability. (For examples of the types of questions asked by the WP2 program, see Appendix B.)

Writing Ability. A two-way ANOVA with repeated measures was used to assess changes in students' writing ability as a result of working with the word processor and the WP2. Treatment group (word processor and WP2) was the between factor and time (pre- to post test) was the within factor. Scores on the narrative writing task was the dependent variable. No significant main effects were found for treatment group or time indicating that there was not significant improvement of writing ability for either group.

Discussion

The present study set out to explore the impact of a metacognitive computer tool on classroom learning environment and students' perceptions of such a tool. The study also investigated whether working with a metacognitive computer tool would create a zone of proximal development (Vygotsky, 1978) for students and result in students internalizing the tool's metacognitive features. Observation results revealed that when an equitable learning environment is established and an integrated gender seating arrangement is allowed, not only do many of the previously found gender differences disappear, but cross-gender interaction is common and quite productive. Student collaboration also appeared to decrease as a result of working with the WP2 which may indicate that students were approaching the interaction with the WP2 as a

partnership and therefore, required less help from their peers. This result raises an interesting issue concerning who is the peer giving the feedback -- the computer or another student. Current research regarding the writing process has emphasized the role of peer editing and its positive influences on students' writing (Harste, Short, & Burke, 1988). Whether the computer acting as a peer has the same results needs further investigation as the results of the present study regarding enhanced writing ability were mixed.

Students' interview responses revealed that while the word processor made the physical process of writing and editing easier, most students concluded it did not help their actual writing. In contrast, most students were able to see how the WP2 might help them become better writers. Students' responses in the second interview revealed that they viewed the WP2 as a partner that was helping them to perform at their optimal level of writing ability and that their writing was better as a result of working with the WP2. Hence, a zone of proximal development was created. Later interviews revealed that students believed working with the WP2 had influenced their writing even though they were no longer using it. Consequently, students' interview responses indicated that working with the WP2 resulted in both effects "with" and effects "of." Students felt that their current writing was better as a result of having worked with the WP2 which suggests that internalization of the program's metacognitive features had occurred. These results would seem to indicate that at least in the area of perceived self-efficacy, long-term effects were achieved (Krendl & Lieberman, 1988).

The most salient influences of working with the WP2 were elaboration, monitoring, organization and planning. These factors were mentioned consistently by students across all three interviews regarding how working with the WP2 had influenced their writing. Four months after the students had stopped working with WP2, they were able to give specific examples of how their writing had improved in the areas of elaboration, organization, and planning. Moreover, it would appear that the metacognitive questions were accountable for changes in elaboration and monitoring as students consistently responded that the purpose of the questions was to help in these two areas. The planning and organization features occurred in the program before students started writing and being exposed to the metacognitive questions which accounts for why these factors were not mentioned in connection with the purpose of the questions. Consequently, it appears that the planning and organizational features of the program, along with the metacognitive questions provided by the program, had substantial impact on students' perceived improvement in their writing ability.

Students' interview responses indicated they had internalized features of the WP2 which resulted in perceived improvement in writing ability. Their written narratives, however, revealed contradictory results. The non-significant results on the narrative writing task would seem to indicate that students did not internalize the metacognitive features of the program. Several factors may help explain this finding. First, it is possible that students did not work with the WP2 for a long enough period of time for internalization to occur. Students worked with the WP2 2 days a

week for 6 weeks, for a total of 12 class sessions. Daiute (1985) states if word processors are to be related to improved writing, it is likely to take longer than a school term. Therefore, it is probable that it may take even longer for students to fully internalize the metacognitive aspects of a word processing program such as the WP2.

One student's response in the second interview would support this conclusion. In response to how this student thought working with WP2 would affect future writing, she responded that the increase in detail in current writing probably would not continue because the questions (provided by the program) would no longer be there and that more time was needed to work with the program. Comparing the number of categories generated in the domain analysis for the topics of Effects With and Effects Of also would support the notion that the effects *with* the WP2 were greater than the effects *of*. Students generated nine different ways they felt their writing was affected while using the WP2 (effects with) in the second interview (see Table 2), and seven ways in the third interview (see Table 3). In contrast, when asked how students thought working with the WP2 would affect their future or current writing (effects of), students only generated three different ways in the second interview (see Table 2) and four ways in the third interview (see Table 3). The fact that students were able to generate more ways the WP2 would help their writing when talking about writing with it than without it suggests that perhaps students needed more time with the program to internalize its features and

begin to think how it would influence their writing when no longer using it.

Second, the context of the writing task may have hindered students from writing at their maximum ability. When writing with the WP2, students were free to choose their own topics and had several days to write their narratives. During the writing assessment task, however, students were given a prompt to write from and had a time limit of approximately 40 minutes. It is possible that these constraints presented powerful enough barriers to prohibit students from utilizing any internalized effects gained from working with WP2. Students' interview responses lend support to the conclusion that some internalization did occur. All five students in the third interview were able to give specific examples of how their writing was now different as a result of working with the WP2. Therefore, it is likely that the conditions of the writing assessment task prevented such internalization from being manifested.

A third explanation is that students' perceived self-efficacy regarding writing ability does not directly affect their writing performance. Previous research has found that while self-efficacy beliefs are a strong predictor of writing achievement they are independent from actual performance skills (Paris & Oka, 1986; Shell, Murphy & Bruning, 1989). The results of the current study appear to be consistent with that conclusion as well as provide additional support for the independent relationship between self-efficacy and writing performance. Whereas previous research has used paper and pencil tasks to measure perceived self-efficacy, the

present study used student interviews. The finding of similar results across different methodologies lends further support to the conclusion that self-efficacy beliefs are independent from actual performance.

Conclusions

The present study was designed to investigate how the introduction of a metacognitve computer tool influences the classroom environment and to explore both effects "*with*" and effects "*of*" working with such a computer tool. The results of this study indicate that traditional gender differences can be decreased by creating an equitable learning environment where cross-gender interaction is facilitated through an integrated seating arrangement. A positive result of working with the WP2 that warrants further attention is the students' enhanced perceived self-efficacy regarding their writing ability as students who have positive beliefs about their writing ability are likely to write more and as a consequence, improve their writing ability (Bereiter & Scardamalia, 1987). Students' interview responses clearly indicated that both effects *with* and *of* working with an intelligent computer tool occurred. Their writing samples, however, revealed no significant improvement in writing performance which supports the notion that self-efficacy beliefs are independent from writing performance. The study also revealed that if internalization of a computer program's metacognitive capacities is desired, the element of time cannot be overlooked. Working with the WP2 appeared to create a zone of proximal development for students in a relatively short period of time (effects with). For students to be able to internalize

the type of support provided by the computer (effects of), however, is likely to take a much longer period of time. Since the interview results suggested that effects *with* were stronger than effects *of*, students' narratives written while working with the WP2 are currently being analyzed to explore whether their writing improved when able to use the computer tool.

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Table 1

Effects On Writing With Word Processor:

Interview 1:

Edit	---- easy to correct mistakes
	---- can use different fonts
	---- corrects spelling
	---- helps with vocabulary
Time	---- takes less time
	---- don't have to copy writing
Practical	---- learn to type
	---- learn about computers
Physical	---- hand doesn't get cramped

Interview 2: This question was not asked in the second interview.

Interview 3:

Time	---- it's faster

Table 2

Effects On Writing "With" Writing Partner2:

Interview 1:

Elaborate ---- adds detail to your story
Monitor ---- helps you recognize irrelevant information
Organization---- tells you what you're missing
Planning ---- gives you more of an idea what you're writing
Generate Ideas---gives you time to think up more
General ---- improves your writing

Interview 2:

Elaborate ---- helps you add detail
Organization ---- it helped me organize my story
Monitor ---- helped me think about what I was writing
Planning ---- you plan out your story so you don't forget it when you're writing
Audience ---- makes you think of who you're writing
Promote Thinking ---- helped me use more thinking power it made me think more
Promote Writing Efficacy ---- my story seemed so much better than the ones I wrote in the past
Enjoyment ---- I really enjoy writing now, it's my favorite hobby
Generate Ideas--- I'm getting more ideas

Interview 3:

Elaborate ---- it asks questions that make you describe more and add more detail
Monitor ---- tells you what's wrong with your story
Organization---- helps sort of set your story so you won't get your thoughts mixed up
Planning ---- helps get all my thoughts together
---- you get all your ideas on the computer so you don't lose them
Generate Ideas----I came up with more ideas
Promote Writing Efficacy ---- my story was better
Clarity ---- my story was more explainable

Table 3

Effects "Of" Writing with Writing Partner2:

Interview 2 (Future Writing):

Elaborate	----	I'll continue to put more detail in my stories
Monitor	----	I'll ask myself questions as I write about how the story comes around each character
Audience	----	I think about who I'm writing for and what they would understand
Still need program	----	probably won't add as much detail because I won't have the questions
	----	needed more time working with WP2

Interview 3 (Current Writing):

Elaborate	----	I describe more and I write more
Organization	----	I know where things go (in my story)
Planning	----	I think about what I'm going to write instead of just writing
Clarity	----	I know to be more specific in my sentences and not write in short, choppy, little sentences

Table 4

Purpose of Questions:

Interview 1:

Elaborate	---- adds detail (to story)
	---- helps you elaborate
Monitor	---- recognize irrelevant information
Promote Thinking	---- to make you think
General	---- help you do it right

Interview 2:

Elaborate	---- to put more detail in story
Monitor	---- to tell you where you were (in your story)
Audience	---- to make you think of who you're writing for
Clarity	---- help readers understand story more

Interview 3:

Elaborate	---- to describe everything
Monitor	---- make you think if this was really what you wanted in your story
Clarity	---- to get your story to make more sense
General	---- to help you
	---- to have a good story

Appendix A

Rubric for Scoring Students' Narratives

Score:	Essays Should Contain:
6	detail, sophisticated control of form and word choice, plot development and characterization, variety and development in use of language, sentence variety, novel/original/fresh approach
5	approach not necessarily novel or doesn't come off, plot development and characterization, good form control, detail, all literary elements
4	control of form, characters fully developed, audience awareness, beginning/middle/end to plot, language establishes (or attempts to establish) setting/mood/character
3	underdeveloped, awkward plot, lacks variety/depth, weak plot/characterization, language use is simplistic
2	beginning but no resolution, one element concentration, linear plot, some literary elements
1	no detail, no character development, no elaboration, no sentence variety, mostly simplistic, could be short, lack of plot, flat, cliche, language doesn't contribute

Appendix B

Examples of Metacognitive Questions Asked by the WP2

Does the order of the events make sense?

What qualities make this person good?

Does this person seem real?

What qualities make this person bad?

Does this person have ANY good qualities?

What makes this character interesting?

How do the characters feel about the setting?

Have you provided some surprises?

What would be an interesting twist of fate?

What good detail could liven up your story?